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(54) Ram air turbine deployment actuator having locking means

(57) An actuator (24) for a ram air turbine system (10) includes a lock bolt (52) having a multiple circumferentially arranged lateral supports (78). A piston rod (42) supports multiple up-lock wedges (48). Multiple rollers (76) are supported by the lateral supports with chamfers (96) on the rollers engaging one another and are configured to radially support the up-lock wedges in a retracted position.

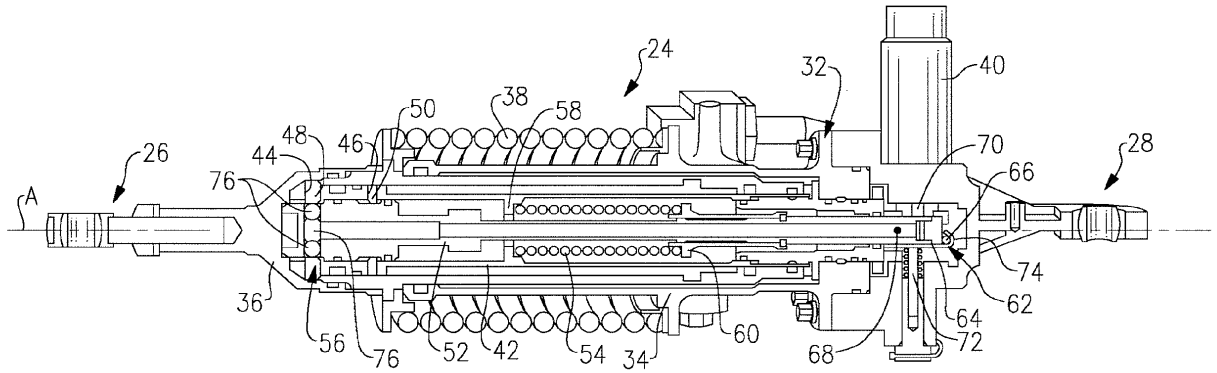

FIG.3

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Description

BACKGROUND

[0001] This disclosure relates to a ram air turbine (RAT) deployment system, and more particularly, the disclosure relates to an actuator for the system.

[0002] Ram Air Turbines (RATs) are utilized on numerous aircraft to provide hydraulic and electrical power in emergency situations. The RAT is stowed in the aircraft structure and deployed into the air stream by a deployment actuator. The deployment actuator is attached to aircraft structure and to an arm on the strut of the RAT. On deployment, the deployment actuator forces the RAT to rotate out of its stowed, or retracted, position in the aircraft and into the air stream. The air stream acts on the RAT blades to spin the turbine and governor assembly, which in turn operates an electrical generator and hydraulic pump providing power to the aircraft. The RAT is held in the aircraft by an up-lock mechanism and is restrained in the deployed position by a down-lock mechanism, both of which are contained within the deployment actuator.

[0003] Typical up-lock and down-lock mechanisms utilize locking wedges, which restrain the actuator in either the stowed or deployed position. Deploying the actuator when only limited electrical power is available in emergency cases is challenging. The loads on the actuator in a deployment scenario can become relatively high due to aircraft flight conditions. These emergency conditions can generate high door loads when attempting to push the RAT into the air stream in-flight. Various wedge arrangements have been used to lock the actuator into position in numerous actuators. In one example, four up-lock wedges are released by sliding the lock bolt across an inner diameter of the wedges such that the wedges drop into a groove in the lock bolt that then releases the actuator to deploy the RAT.

[0004] In another example hydraulic locking actuator, rollers are used between two wedges to reduce the amount of force required to move the lock bolt to release the actuator. But, the load that can be applied to the actuator is limited.

SUMMARY

[0005] An actuator for a ram air turbine system includes a lock bolt having a central support. A piston rod supports multiple up-lock wedges. Multiple rollers are supported in the lock bolt and are configured to radially support the up-lock wedges in a retracted position. The rollers include chamfers engaging one another.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The disclosure can be further understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 is a perspective view of a RAT in a deployed position.

Figure 2 is a perspective view of an actuator illustrated in Figure 1 in a stowed or retracted position prior to deployment of the RAT.

Figure 3 is a cross-sectional view of the actuator illustrated in Figure 2.

Figure 4A is a cross-sectional view of the actuator similar to Figure 3, but with the lock bolt released by a latch assembly.

Figure 4B is an enlarged view of the actuator illustrated in Figure 4A.

Figure 4C is a cross-sectional view of the actuator along line 4C-4C in Figure 4B.

Figure 5 is a cross-sectional view of the actuator with up-lock wedges released.

Figure 6 is a cross-sectional view of the actuator in a fully deployed position.

Figure 7 is a cross-sectional view of the actuator in a fully deployed position with the down-lock wedges engaged.

DETAILED DESCRIPTION

[0007] Figure 1 illustrates a RAT system 10 secured to an aircraft structure 12 by a housing 14. The housing 14 pivotally supports a strut 16 having a turbine 18 at one end. The turbine 18 includes blades 20, which impart rotational drive to a generator 22 and a hydraulic pump 30. An actuator 24 is secured to the strut 16 at a first end 26 and to the housing at a second end 28. The actuator 24 is illustrated in its deployed position.

[0008] Referring to Figures 2 and 3, the actuator 24 includes a housing 32 having first cylinder 34 and second separate cylinder 36, unattached to housing 32, telescopically arranged relative to one another. A deploy spring 38 is arranged between the first and second cylinders 34, 36 in a compressed state with the actuator 24 in its retracted position. A deploy solenoid 40 is mounted on the housing 32 and is actuated to initiate a deploy sequence within the actuator 24.

[0009] The second cylinder 36 is received within the first cylinder 34. A piston rod 42 is affixed to the housing 32 such that it is rigidly attached to the first cylinder 34, such that the second cylinder 36 slides between and relative to the piston rod 42 and the first cylinder 34. The piston rod 42 includes first and second apertures 44, 46, which respectively receive up-lock and down-lock wedges 48, 50. A lock bolt 52 is arranged slideably within the piston rod 42 to actuate the up-lock and down-lock wedges 48, 50 during the deploy sequence. The piston rod 42 includes a flange 58 and a collar 60 spaced apart from one another. A lock bolt spring 54 is provided between and engages the flange 58 and collar 60 to bias the piston rod 42 and lock bolt 52 apart along the axis A. A roller assembly 56 is supported by the lock bolt 52 and ar-

ranged radially between the lock bolt 52 and the up-lock wedges 48.

[0010] A latch assembly 62 is provided in the housing 32 near the deploy solenoid 40. A lever 64 is pivotally supported by a pivot 68 at one end, and the lever 64 includes a latch pin 66 opposite the pivot 68. A biasing member 72 maintains the lever 64 in a normally retracted position. The latch pin 66 engages an end 74 of the lock bolt 52 in the retracted position. A rod 70 extending from the deploy solenoid 40 cooperates with the lever 64 to move the lever 64 from a retracted position (Figure 3) to a deployed position (Figure 4A).

[0011] In operation, to initiate a deploy sequence, the deploy solenoid 40 moves the rod 70 to rotate the lever 64 about the pivot 68, which disengages the latch pin 66 from the end 74, overcoming the biasing force from lock bolt spring 54. With the latch pin 66 disengaged from the end 74, the lock bolt 52 is forced to move axially (to the right in Figure 4A) in response to the biasing force from lock bolt spring 54.

[0012] Referring to Figures 4A-4C, movement of the roller assembly 56 (to the right in the Figures) permits the up-lock wedges 48 to move radially inward and disengage from the cylinders 36 thereby enabling the second cylinder 36 to move axially away from the first cylinder 34. The roller assembly 56, as illustrated in Figures 4A-4C, is depicted in the retracted position. The roller assembly 56 includes rollers 76 supported by a lateral support 78 of the lock bolt 52. The rollers 76 are provided in slots 90 evenly spaced circumferentially in the lock bolt 52. The lateral support 78 includes two flat surfaces 86 and 87, provided by each slot 90, that support the rollers 76. The slots in the slots 90 offer line contact L with the rollers 76, retaining them axially. This line contact is the only friction the rollers experience with respect to the lock bolt 52 allowing a smaller lock bolt spring 54. The flat surfaces 86 and 87 are perpendicular to axis A of the actuator. The lock bolt 52, used to space the rollers 76 evenly about the circumference of the lock bolt and in a plane perpendicular to the axis A, retains four rollers 76 axially. The rollers 76 are supported radially by their own corner chamfers 96 which rest against one another. The four rollers radially support four up-lock wedges 48 in the same plane which are retained axially by piston rod 42.

[0013] The second cylinder 36 includes a beveled surface 80. The up-lock wedges 48 include a first angled surface 82 that engages the beveled surfaces 80. The rollers 76 support an inner surface 84 of the up-lock wedges 48. A second angled surface 88 is provided on the up-lock wedges 48 near the rollers 76 opposite the first angled surface 82.

[0014] Each roller 76 includes ends 92 opposite one another that provide a clearance 94 between the rollers 76 and the slots 90 to enable axial movement of the roller 76 along a roller axis R. Each roller 76 includes chamfers 96 at either end 92. The chamfers 96 of the rollers 76 engage one another with the provided clearance 94 to accommodate misalignment with the components and support the roller loading due to reacting the up-lock wedge 48 loads developed from the contact of surfaces 80 and 82. For the example arrangement, in which four rollers are used, the chamfers are at a 45° angle relative to the cylindrical roller bearing surface of the rollers 76. In this manner, the loads amongst the rollers 76 are shared between the mating chamfers 96 and the frictional loads are reduced due to the rolling contact between the roller chamfers 96. Thus, the loads on the up-lock wedges 48 are more evenly distributed, which enables a higher capacity actuator with reduced release force. It should be understood that the number of wedges and the number of rollers may vary for other actuator applications depending on the loads.

[0015] Referring to Figures 5-7, the lock bolt spring 54 continues to move the lock bolt 52 (to the right in the Figures), enabled by the roller assembly 56 sliding relatively easily within the piston rod 42. Once the rollers 76 have moved out of engagement with the inner surface 84 of the up-lock wedges 48, the beveled surface 80 forces the up-lock wedges 48 radially inwardly in response to the force of the deploy spring 38, as illustrated in Figure 5. The lock bolt 52 moves axially relative to the piston rod 42 until a stop 98 engages the down-lock wedges 50.

[0016] The second cylinder 36 continues to move axially outwardly relative to the first cylinder 34 until a stop 100 on the piston rod 42 engages a surface on the second cylinder 36, limiting its axial position relative to the first cylinder 34 (Figure 6). The lock bolt 52 continues to move axially to the right in response to the force from the lock bolt spring 54 applied to a beveled surface 102 of the lock bolt 52 forces the down-lock wedges 50 radially outward into a groove 104 of the second cylinder 36.

[0017] Although an example embodiment has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of the claims. For that reason, the following claims should be studied to determine their true scope and content.

Claims

1. An actuator (24) for a ram air turbine system (10) comprising:

   a lock bolt (52) providing multiple circumferentially arranged lateral supports (78);
   a piston rod (42) supporting multiple up-lock wedges (48); and
   multiple rollers (76), each of which are supported in one of the lateral supports and are configured to radially support the up-lock wedges in a retracted position, the rollers including chamfers (96) engaging one another.

2. The actuator according to claim 1, wherein the lock bolt (52) includes slots (90) providing the lateral sup-

ports (78), the rollers (76) being arranged in the slots.

3. The actuator according to claim 2, comprising a clearance (94) between each roller (76) and its corresponding slot (90) to permit axial movement of each roller within its respective slot.

4. The actuator according to claim 3, wherein the lateral supports (78) allow the rollers (76) to provide load sharing between all the up-lock wedges (48) by moving both radially due to the roller chamfers (96) and axially due to the clearance (94) between each roller and its respective slot (90).

5. The actuator according to any preceding claim, wherein each roller (76) includes opposing ends (92) each having the chamfer (96).

6. The actuator according to claim 5, wherein the multiple rollers (76) are provided by four rollers having a 45° chamfer (96) at the opposing ends (92).

7. The actuator according to any preceding claim, comprising first and second cylinders (34,36) telescopically arranged relative to one another and configured to be biased axially away from one another by a deploy spring (38), the piston rod (42) and lock bolt (52) being arranged within the second cylinder (36).

8. The actuator according to any preceding claim, comprising a latch assembly (62) cooperating with the lock bolt (52) and configured to move between retracted and deployed positions, and a lock bolt spring (54) configured to bias the piston rod (42) and lock bolt away from one another with the latch assembly in the deployed position.

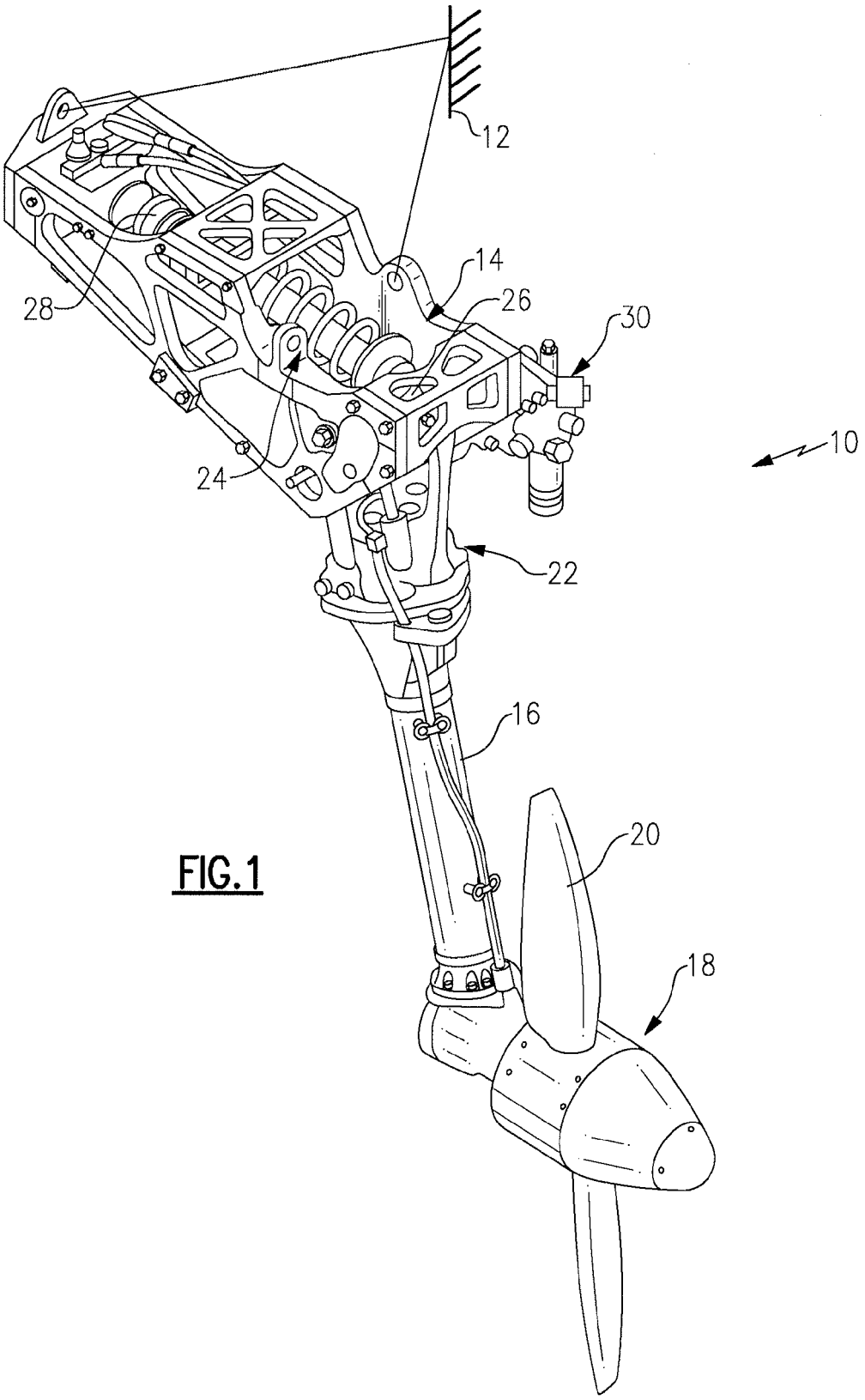

FIG.1

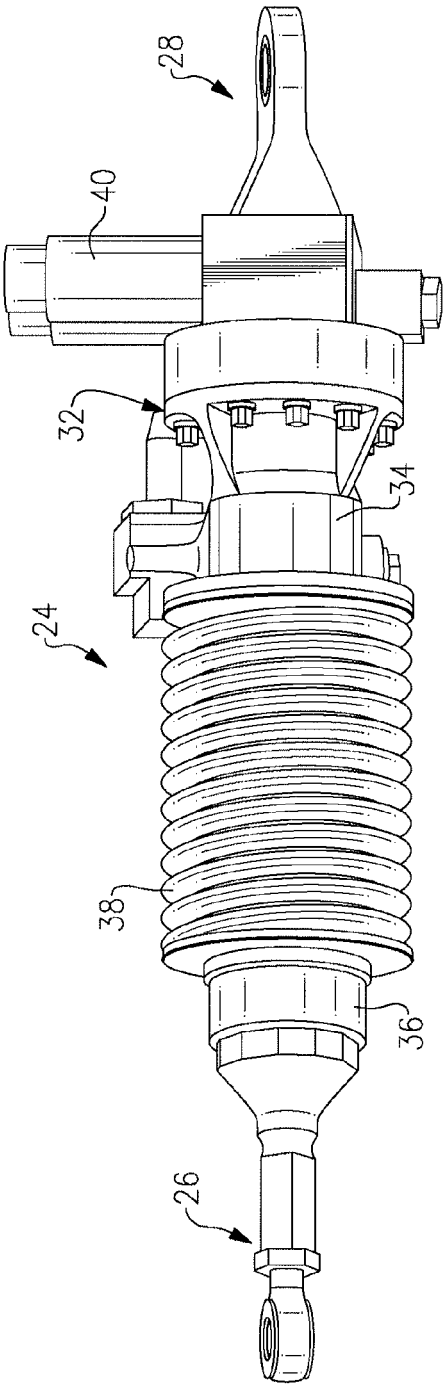
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FIG.2

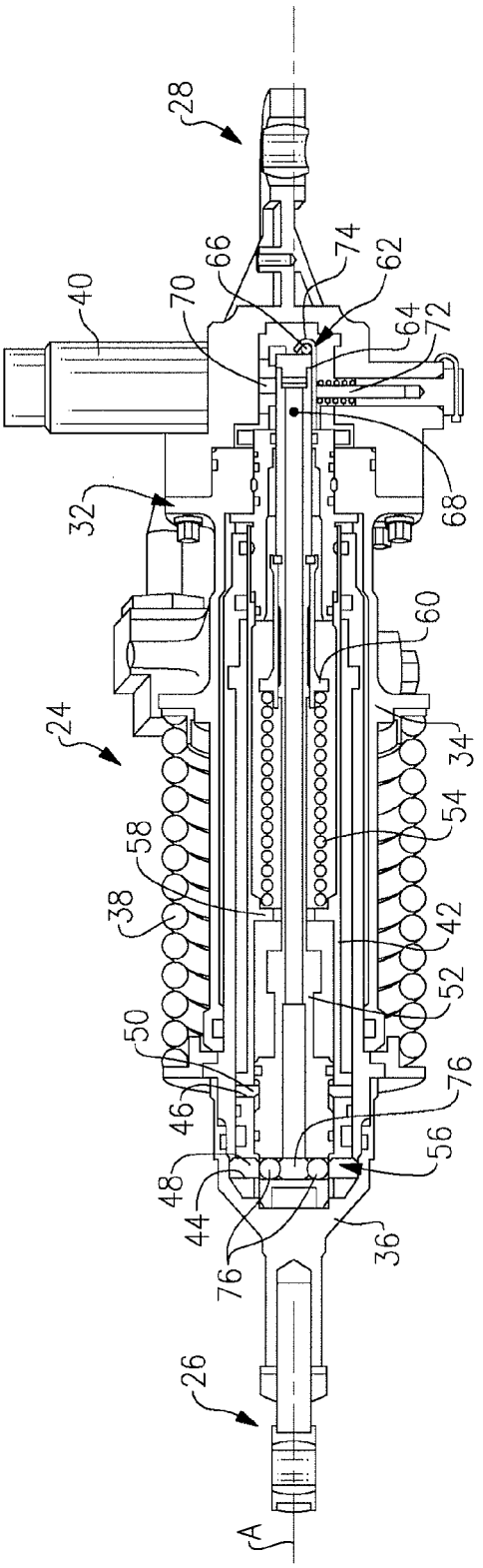
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FIG.3

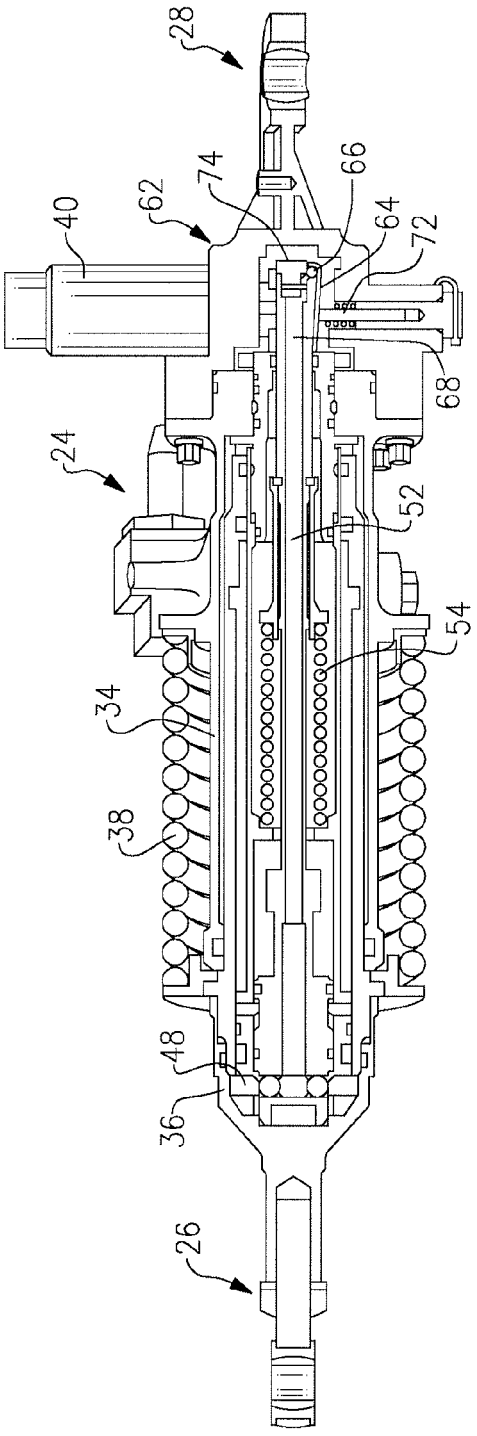
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FIG.4A

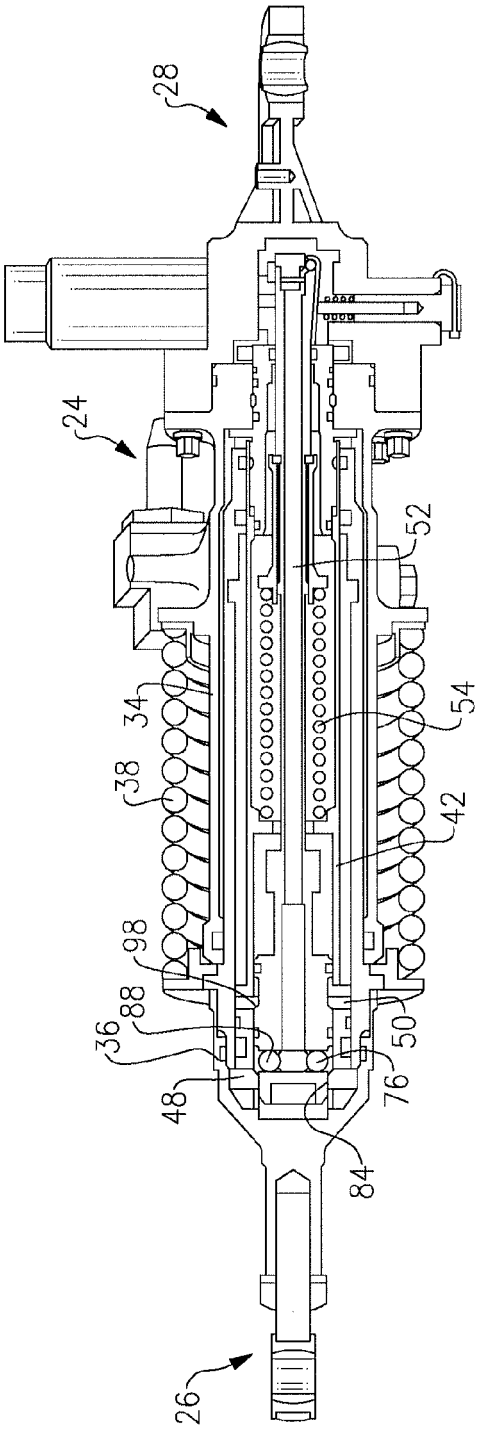
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FIG.5

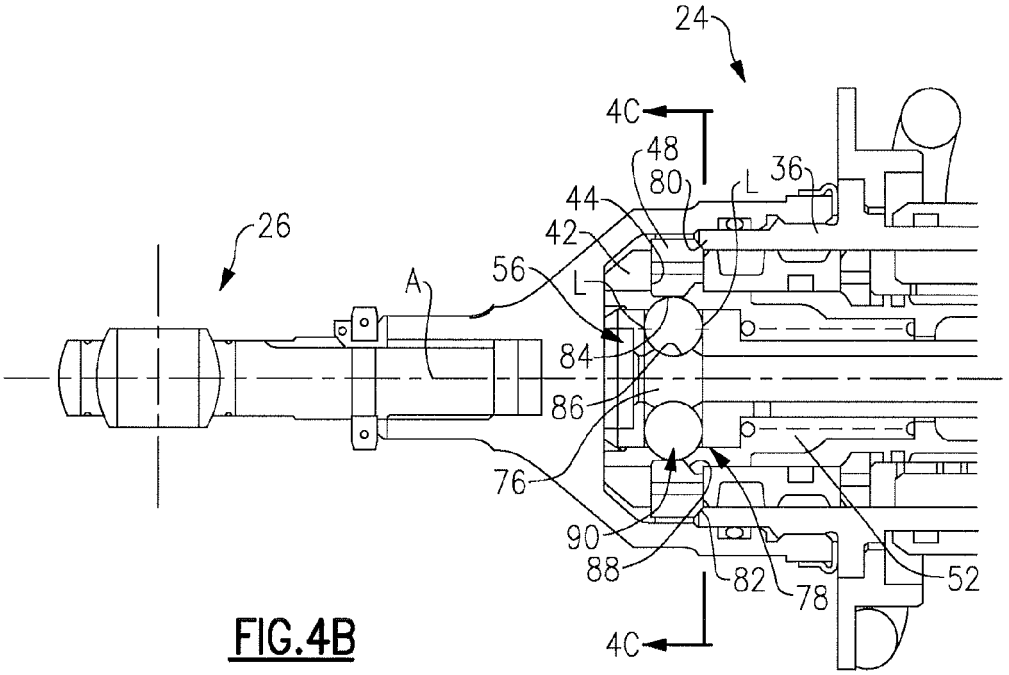
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FIG.4B

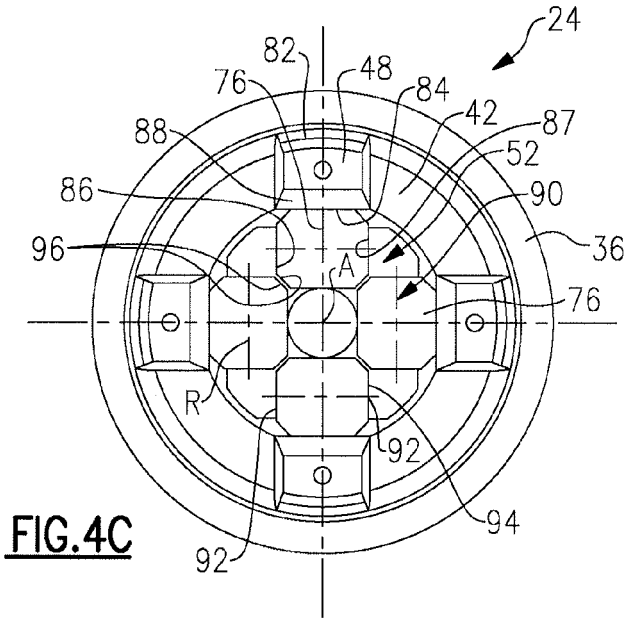
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FIG.4C

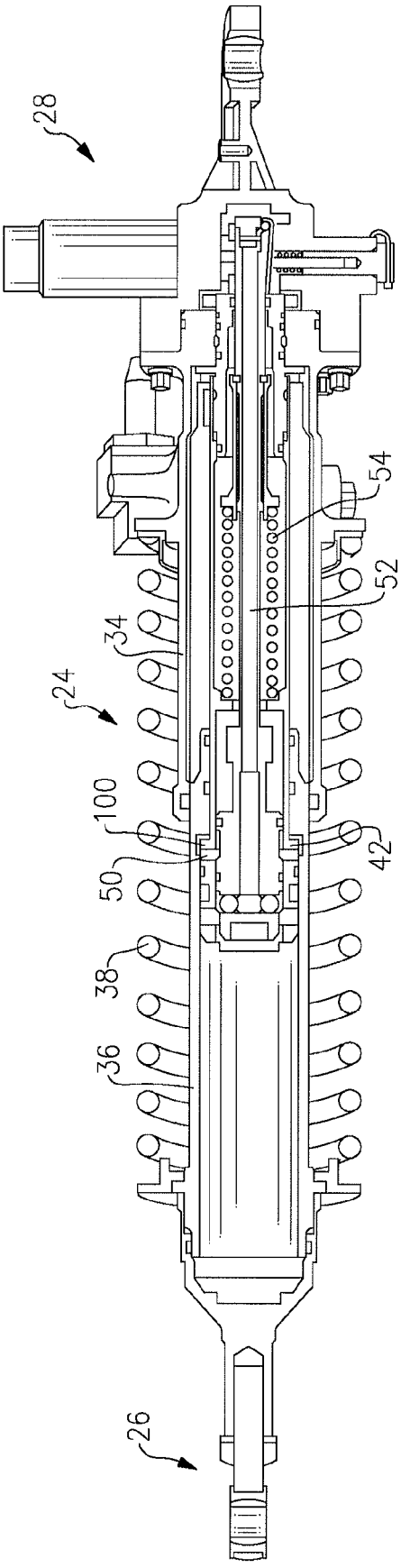

FIG.6

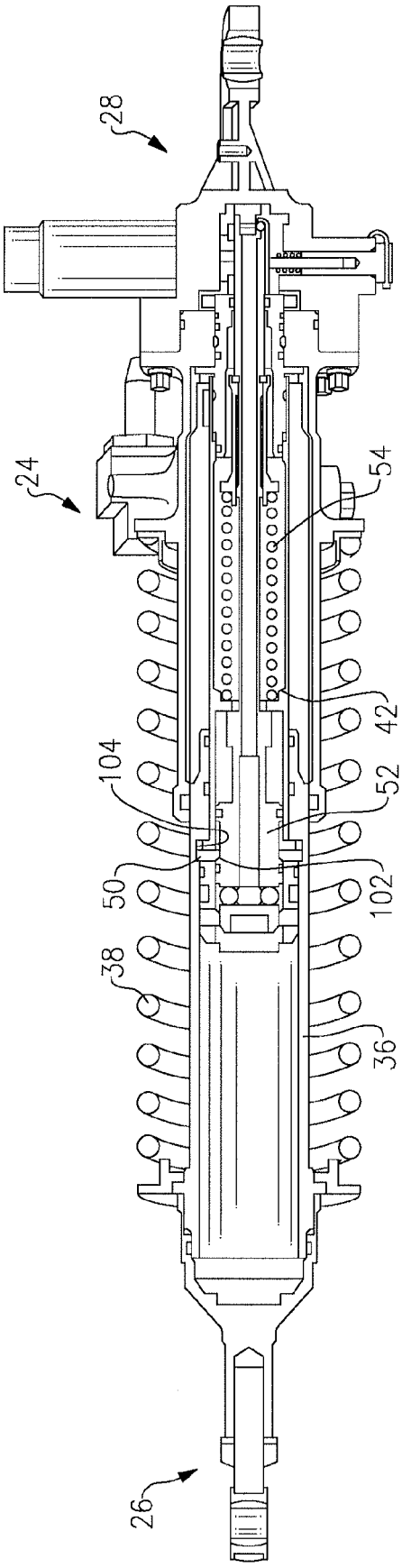

FIG.7

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 6240

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2007/237640 A1 (RUSS DAVID E [US]) 11 October 2007 (2007-10-11) * the whole document *	1	INV. F16B7/10 B64D41/00 F16D43/208
A	US 2 764 132 A (BAKKE EDGAR H) 25 September 1956 (1956-09-25) * the whole document *	1	F16D7/10 F16B7/14
A	US 3 469 871 A (BETTS ROBERT E) 30 September 1969 (1969-09-30) * the whole document *	1	
A	US 3 107 933 A (ROYSTER ROBERT H) 22 October 1963 (1963-10-22) * the whole document *	1	
A	US 3 813 065 A (HALLESY H ET AL) 28 May 1974 (1974-05-28) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F16B
B64D
F16D
F15B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 August 2012	Masset, Candie

CATEGORY OF CITED DOCUMENTS

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07-08-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007237640 A1	11-10-2007	NONE	
US 2764132 A	25-09-1956	NONE	
US 3469871 A	30-09-1969	NONE	
US 3107933 A	22-10-1963	NONE	
US 3813065 A	28-05-1974	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82